

ISSN 1327-8231

ECONOMICS, ECOLOGY AND THE ENVIRONMENT

Working Paper No. 105

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THE UNIVERSITY OF QUEENSLAND

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WORKING PAPERS IN THE SERIES, *Economics, Ecology and the Environment* are published by the School of Economics, University of Queensland, 4072, Australia, as follow up to the Australian Centre for International Agricultural Research Project 40 of which Professor Clem Tisdell was the Project Leader. Views expressed in these working papers are those of their authors and not necessarily of any of the organisations associated with the Project. They should not be reproduced in whole or in part without the written permission of the Project Leader. It is planned to publish contributions to this series over the next few years.

Research for ACIAR project 40, *Economic impact and rural adjustments to nature conservation (biodiversity) programmes: A case study of Xishuangbanna Dai Autonomous Prefecture, Yunnan, China* was sponsored by the Australian Centre for International Agricultural Research (ACIAR), GPO Box 1571, Canberra, ACT, 2601, Australia.

The research for ACIAR project 40 has led in part, to the research being carried out in this current series.

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Glow Worms as a Tourist Attraction in Springbrook National Park: Visitor Attitudes and Economic Issues

Abstract

Insect-based tourism mainly caters to a niche market, but its popularity has been growing in recent years. Despite its popularity this form of tourism has remained under-researched and in a sense its contribution to the tourism industry has gone mostly unnoticed. This paper reports the results of a study undertaken on one form of popular insect-based tourism, namely glow worms. The study was undertaken in Springbrook National Park (Natural Bridge section) southeast Queensland, which has one of the largest glow worm colonies in Australia that attracts thousands of visitors each year.

A study of this form of tourism is important and useful for several reasons. It is important to understand this hitherto under-studied tourism activity to determine the type of visitors, their socio-economic attributes, economic benefits to the local economy, visitors' knowledge of glow worms, education imparted, visitor satisfaction of glow worm viewing and visitor attitudes for the introduction of a user fee system to view glow worms. An understanding of these issues could not only help to better manage this valuable biological resource, but can be used to develop the industry to cater to a growing number of visitors. Tourism in glow worms can potentially be used not only to educate the public on the threats affecting glow worms and their colonies, but could also be used to conserve them. Lessons learnt from glow worms as an attraction to Springbrook National Park can be used to better manage and further develop other existing and new glow worm sites in Australia and elsewhere for tourism. Furthermore, it could provide some guidance for the management and development of other forms of current insect-based tourism activities (eg. butterflies) and develop new tourism ventures based on species such as stick insects and jewel beetles for which Australia is well known (Reader's Digest, 1997)

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Glow Worms as a Tourist Attraction in Springbrook National Park: Visitor Attitudes and Economic Issues

1. Background and Introduction

Insect-based tourism is a particular form of wildlife tourism that has remained mostly unnoticed despite its potential for further development as a tourism draw card. For instance, there are many insects such as butterflies, stick insects, jewel beetles, and fireflies that can be potentially used for tourism purposes. Australia is home to 1200 species of jewel beetles (Brunet, 2000) that have hardly been used for tourism purposes except in museum displays such as in the Queensland museum, Brisbane where such insects are a visitor attraction. Some form of commercial activity takes place with other insects (eg. stick insects), but (except in the case of butterflies) is limited. There are already several tourism ventures based on insects in many countries and they are popular among visitors. Some of the better insect-based tourism activities involve butterflies, dragonflies and glow worms. For example, butterfly and glow worm viewing are popular tourism activities in New Zealand and Australia. Despite its popularity and its economic importance to the tourism industry no detailed study has been undertaken to date to study the socio-economic and related aspects of this niche industry.

This study helps to rectify this situation and provides some insights into glow worm viewing in the Springbrook National Park (Natural Bridge section) in southeast Queensland, Australia. This park is World Heritage listed as part of Central Eastern Rainforest Reserves of Australia (CERRA). A study of this nature provides an introduction to the demand for insect-based tourism and the large economic potential that exists for insect-based tourism, both in Australia and elsewhere.

Commercial activity associated with insect-based tourism could lead to research being undertaken to conserve and better manage the species as is happening with the case of glow worms. Furthermore, the visitors who come to view these attractions can be informed about the issues affecting the conservation of insects such as glow worms and may even contribute money for their conservation. This is may be especially important for insects that do not have tangible economic use values at present but have several economic non-use values such as existence and bequest values.

Funding of conservation can also have an economic value because it maintains future use options. A good example of a future value for glow worms is the potential to discover the chemical and genetic basis of their bioluminescence. The luciferase enzyme isolated from another bioluminescent insect, the North American firefly, is being used to measure gene expression in living animals (O'Connell-Rodwell et al., 2002). Therefore, in situations where there is no immediate economic value, the money allocated for their conservation is likely to remain limited or even non-existent. For instance, the Mt Buffalo glow worm has a distribution restricted to a sub-alpine cave in Mt Buffalo, Victoria and has been listed as a threatened species (Baker, 2003). Tourism has the potential to raise money for its conservation and even provide a commercial incentive to breed this species for tourism purposes as is done privately with *Arachnocampa flava* in Springbrook, Queensland. Prospects are promising since the breeding of glow worms has been achieved in several places (Baker and Merritt, 2003; Takaie, 1989). Many species of insects are endangered in Australia (Reader's Digest, 1997) and need assistance for their survival.

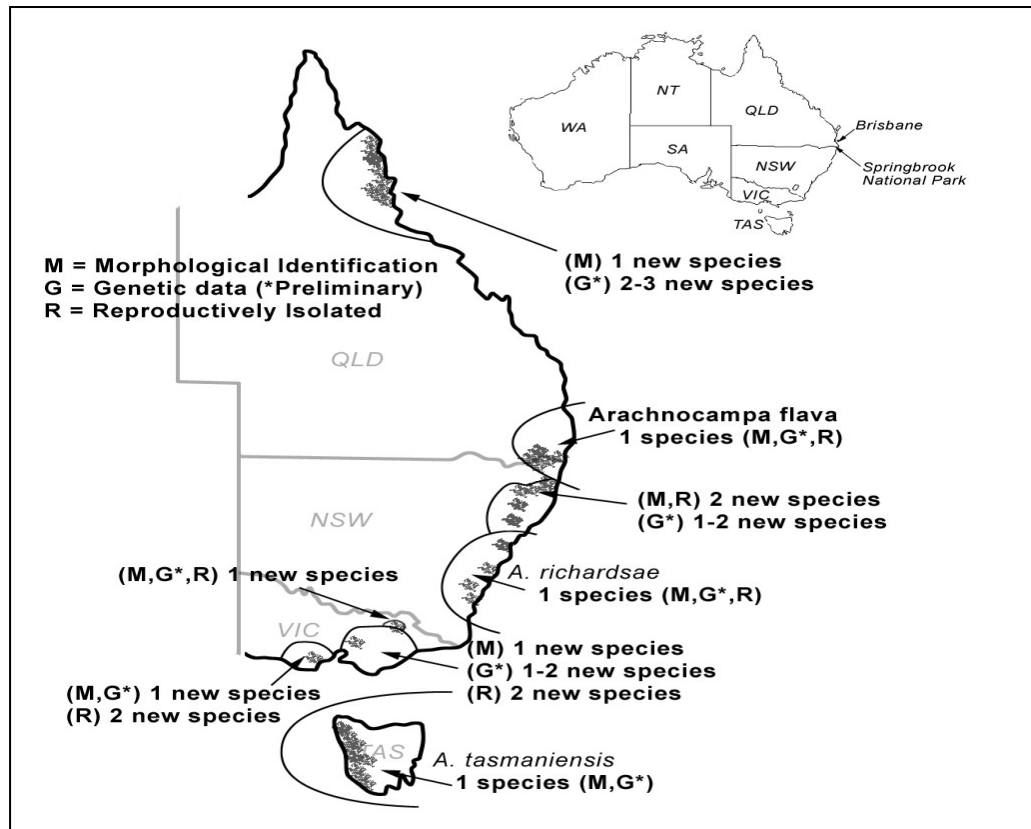
The first section of this study discusses issues related to glow worms and glow worm related tourism activities in general and introduces glow worm-based tourism in Springbrook National Park (Natural Bridge Section). Section two explains the purpose of the survey and the methodology employed to collect the data. The third reports the results and discusses the findings of a survey of 'walk-in' visitors to the glow worm attraction at Natural Bridge which include the profile of visitors, the importance of glow worms as a tourist attraction, both economic and social, visitors' knowledge of glow worms and related issues. The final section discusses the findings of the study.

2. Glow Worms and Tourism: Some Issues

Snare-forming glow worms (genus *Arachnocampa*) are found only in Australia and New Zealand. They have been a tourist attraction for several decades, especially at Waitomo Caves in New Zealand. Each year thousands of tourists visit glow worm colony sites to watch them and glow worm viewing has become a commercial activity at several sites. In essence these insects have created a niche market in tourism and are an important economic activity to those involved in such tourism. Commercial stakeholders and tour operators who utilize glow worm colonies include those who have private property rights to glow worm colonies.

The glow worms of the southern hemisphere are immature flies (*Order Diptera*) and are not to be confused with the bioluminescent beetle larvae and adults (*Order Coleoptera*) that go by the same common name. There is one species of glow worm in New Zealand and three in Australia (Pugsley, 1983), with several new species awaiting formal identification and naming (Baker, 2003; Baker, 2002). In Australia, glow worms are distributed widely in regions of high humidity from the rainforests/caves of far north Queensland to Tasmania in the south. A literature search conducted by Baker (2003) shows many identified localities. All known species are confined to eastern Australia as shown in Figure 1 and tourism (small to large scale) is involved in some of these sites in all of the four states namely, Queensland, New South Wales, Victoria and Tasmania. Tourism usually occurs in sites where the glow worm colonies are large.

In Springbrook National Park (Natural Bridge section), where this survey on glow worm tourism was conducted, the greatest abundance of these insects is found in wetter months of the year between October to March and these local climatic variations are believed to affect the display of their glow (Baker, 2002). The species of glow worm found in Natural Bridge is *Arachnocampa flava*, but all species of glow worms have the potential to be tourist attractions.



Source: Based on Baker (2003).

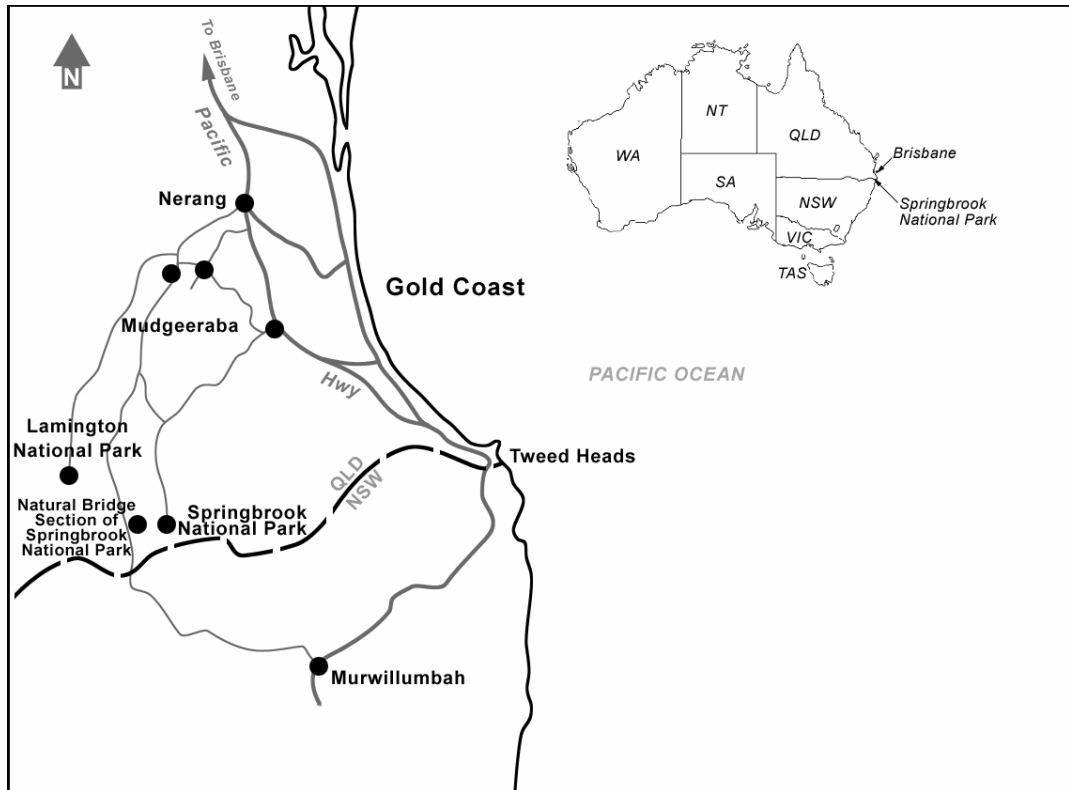
Figure 1: Map showing identified glow worm sites in Australia and the recorded species

As shown in Figure 1, many glow worm species recorded in Australia have a very restricted geographical range and are mostly endemic to the area where they are found. The restricted range may partly be explained by the inability of the adult mosquito-like flies to travel long distances and to colonise new areas (Baker and Merritt, 2003; Richards, 1960).

Like butterflies and dragonflies and many species of insects, glow worms, have distinct developmental stages. For tourism purposes it is the larval, or immature stage that is attractive. Glow worms, unlike larvae of butterflies and moths, are predatory and lure their prey by glowing in the dark to attract prey (insects) that get entangled in the web. The larval stage is the longest and can last up to one year depending on the availability of prey and environmental conditions (Baker, 2003). However, once the larva pupate and become adults their life span is very brief, lasting as little as two days for a female and up to six days for a male (Baker, 2003).

Glow worm viewing in its natural habitat is a night-time activity that occurs in a cave or in a rainforest. However, because of the potential to attract greater number of visitors during the day and to make glow worms easily accessible, some entrepreneurs have created artificial habitats for glow worms to attract day-time (fee-paying) visitors. Artificial habitats for glow worm tourism exist at Springbrook (Forest of Dreams) and are under development at Mt Tamborine (Cedar Creek Estate Vineyard and Winery). Such activity highlights the demand that exists among day visitors for such viewing.

Springbrook National Park (Natural Bridge section) in Queensland (see Figure 2) bordering NSW is well known for its colony of glow worms and attracts a diverse group of visitors. Entry to watch glow worms in the Natural Bridge cave and the surrounding national park is free as is the case with almost all national parks in Queensland, except for a few conservation parks. Although there is no entry fee for independent visitors, Queensland Parks and Wildlife Service (QPWS) has a charge in place for commercial tour operators under the Nature Conservation Act 1992, where all commercial activities in national parks must obtain permits for which there is a fee involved. The permit system has enabled QPWS to maintain rangers close to the glow worm viewing area in the evening/night when commercial tourists visit the site. Furthermore, it helps independent visitors to interact with the rangers and helps visitors to learn more about minimising impacts on the glow worms such as not shining torchlight on them which can affect feeding habits by stopping them to grow. The presence of rangers also gives some protection to the glow worms and to vehicles parked nearby.



Source: Based on QPWS (1999) information brochure on Springbrook National Park (Natural Bridge section)

Figure 2: Map showing Springbrook National Park (Natural Bridge section) colony of glow worms (*Arachnocampa flava*) and its environs

Commercial tour operators bring in large numbers of Asian tourists (eg. from Japan, South Korea, Taiwan, Singapore, Malaysia and Hong Kong) in addition to other visitors (both foreign and Australian) to Natural Bridge. Glow worm tours in Australia, like in New Zealand, are well advertised on the internet by most commercial tour operators.

Statistics collected by QPWS show as many as 300 such visitors are brought on some nights by commercial tour operators, although this number fluctuates according to the arrival of the above mentioned tourists to Australia. Table 1 shows the number of tourists brought by commercial tour operators to Natural Bridge since 2001.

Table 1

Visitors brought by commercial tour operators during the period 2001-2003

Month/ Year	2001	2002	2003	Total
January	6029	4133	5006	15168
February	5995	5730	4035	15760
March	6279	4767	3548	14594
April	6306	3870	3814	13990
May	6199	4553	2141	12893
June	5762	3682	3176	12620
July	6848	3149	3191	13188
August	5893	3153	4030	13076
September	4286	2837	5512	12635
October	4671	4020	3192	11883
November	4990	3960	5863	14813
December	4186	4058	5728	13972
Total	67,444	47,912	49,236	164,592

Source: QPWS (2001-2003) unpublished data.

Notes: Visitor figures are understated. This is because QPWS rangers record data only when they are stationed at the park entrance and often do not record numbers while rangers are on patrol. Furthermore, on certain evenings rangers do not maintain a presence in the park.

As shown in Table 1, visitor numbers brought to Natural Bridge by commercial tour operators averaged more than 50,000 a year during the period 2001-2003. However, numbers have fluctuated from year to year and numbers have dropped. This is partly due to events of September 11, 2001, SARS and drop in Japanese tourism to Australia during the last few years. However, the large numbers of tourists brought in by commercial tour operators demonstrate that glow worms are an important part of the commercial tour operators' operations. In addition to mostly Asian visitors brought by commercial tour operators, many independent visitors, both Australian and foreign, travel to Natural Bridge to view glow worms on their own. Some school, church, youth, elders and sporting clubs are also included in the non-commercial (independent) visitor category which include a range of ages. On average, the number of independent visitors has been around 13,000 for the last three years as shown in Table 2. However, they account for less than 20 percent of visitors coming to Natural Bridge to view glow worms. The majority of the visitors who answered the survey were from Australia and the rest are mainly from Europe, New Zealand and North America. The number of Asian independent visitors is also high.

Table 2**‘Independent’ visitors to Natural Bridge during the period 2001-2003**

Month/ Year	2001	2002	2003	Total
January	1981	1374	1642	4997
February	1580	1210	831	3621
March	1403	856	1192	3451
April	1948	694	1322	3964
May	1139	951	595	2685
June	1330	421	1083	2834
July	1412	655	1349	3416
August	1038	492	1090	2620
September	1020	764	1435	3219
October	951	580	729	2260
November	1040	681	1022	2743
December	1136	874	1549	3559
Total	15,978	9,552	13,839	39,369

Source: QPWS (2001-2003) unpublished data.

Note: Data for ‘independent’ visitors is understated. This is because QPWS rangers record data only when they are stationed at the park entrance and often do not record numbers from independent visitors who enter the park while the rangers are on patrol. Furthermore, on certain evenings rangers do not maintain a presence in the park. They work on average five nights a week.

3. Purpose of Survey and Methodology

Tables 1 and 2 indicate that glow worm viewing is a popular night-time activity in Natural Bridge. If not for the presence of glowing worms, it can be assumed that most of these visitors would not have travelled to Natural Bridge. Glow worms are an economic asset and bring economic benefits to this area and create employment. The economic importance of glow worms is highlighted by the presence of private operators who provide glow worm viewing facilities during the day and at night for fee-paying visitors in Springbrook itself. There are two such sites, namely the ‘Forest of Dreams’ and the ‘Springbrook Research Centre’.

Despite the popularity of glow worms as a tourist attraction in Australia and their potential to attract significant numbers of tourists, generate economic benefits, and create local employment, no detailed study has been undertaken to date to determine the profile of visitors, their expenditures in the local area, satisfaction levels, knowledge gained from the visit, the need to improve facilities, views about overcrowding, the introduction of a user-fee charge, visitors’ knowledge about other glow worm sites and to determine visitors’ background attributes such as gender, age, educational and income levels. Such information can be useful for tourism planning purposes and site management.

In this study only English speaking independent visitors were targeted. The tourists brought in by commercial tour operators were not surveyed. One reason was the language barrier. Another was that these tourists (especially the Asian tourists) have already pre-paid for their whole visit and hence, it was thought that they are unable to answer many of the questions in the survey independently. Furthermore, many of these visitors travel to Natural Bridge as part of an evening tourist package that often involves other attractions and dinner. Because of the differences between these two distinct types of visitors, it was decided to concentrate the study only among independent visitors given our time and budgetary constraints.

Conducting direct interviews was not practical mainly because glow worm watching at this site is a night-time activity and visitors come only for a brief period of time. The best way to obtain the required data we decided was to provide the visitors a survey form together with a postage pre-paid self addressed envelope with instructions to post the completed survey form after the visit in the next few days. Permission was obtained from QPWS to conduct this survey since the distribution of the survey forms was inside the Springbrook National Park (Natural Bridge section). Furthermore, we had to solicit the support of QPWS rangers to hand out the survey forms because it was not financially practical to employ a research assistant for this work.

Survey forms were intended to be handed to each individual person (if travelling alone) or party who visited Natural Bridge for the purpose of watching glow worms from January, 2002 to February, 2004 on a voluntary basis. However, the distribution of survey forms was halted for several months because of the transfer of rangers and new rangers having to be trained. The survey resulted in 177 usable responses with a response rate of 32%[§] covering (after allowing for party sizes) approximately seven percent of the independent visitors in 2002 and 2003. Given the various issues and difficulties involved in conducting a survey of this nature the coverage of visitors and the response rate is satisfactory and is usual for surveys of this nature (Tisdell and Wilson, 2002).

4. Results of the Survey: Profile of Visitors

The majority (84%) of surveyed visitors were from Australia. Of the foreigners most were from Europe, North America and New Zealand. Asians were not well represented, but there

[§] Distribution of 25 survey forms after the survey to double check the response rate, yielded a response rate of 40%.

were visitors from Hong Kong, Singapore and from other countries in South East Asia. One of the reasons why Asians are not well represented is partly because the survey excluded Asian tourists brought by commercial tour operators. Furthermore, survey forms were distributed to only English speaking visitors. Furthermore, language barriers might reduce the response of Asian walk-in groups. In all, visitors from 13 different countries visited Natural Bridge and answered our questionnaire. The nationality of visitors and their percentages are shown in Table 3.

Table 3

Country of residence of surveyed visitors to view glow worms at Natural Bridge

Country	Frequency	% Total
Australia	148	83.6
UK	7	4.0
US	6	3.4
New Zealand	4	2.2
Hong Kong	3	1.7
Singapore	2	1.1
Canada	1	0.6
China	1	0.6
Denmark	1	0.6
Germany	1	0.6
Japan	1	0.6
Malaysia	1	0.6
Thailand	1	0.6
Total	177	100

Of the Australians who visited Natural Bridge, 59% were born in Australia. The rest were migrants, some having lived in Australia for as long as 51 years. As might be expected, most of the Australians were from Queensland, followed by those from NSW and Victoria. NSW is only a few kilometres from Natural Bridge and it is to be expected that the second largest group of visitors are from NSW. The composition of Australian visitors to Natural Bridge by states is shown in Table 4.

Table 4
Distribution of responding Australian walk-in visitors coming to
Natural Bridge to view glow worms by State

State	Frequency	% Total
QLD	113	76.4
NSW	26	17.6
VIC	6	4.1
NT	1	0.7
ACT	1	0.7
WA	1	0.7
TAS	0	0
SA	0	0
Total	148	100*

Table 4 indicates that that distance from the site is a factor that affects number of visits to Natural Bridge. Most of the visitors (58%) said that their visit involved a day excursion and was not part of a journey involving an overnight stay away from home. This is supported by the large number of visitors from QLD and NSW visiting Natural Bridge who had postcodes within three hours travelling distance to Natural Bridge. However, 41% of the respondents said that they were on holiday, that is, a trip involving a stay at least one night away from home. This group included foreigners.

Once the 16% of the foreigners are excluded, only 20% of the visitors said they were on holiday. Approximately 1% did not answer this question. Most of the holiday visitors, although they did not stay close to Natural Bridge, travelled from places such as Brisbane, Gold Coast and the Sunshine Coast which are popular holiday destinations. Most of these visitors went back on the same night to the place where they started their trip. The data show that most visitors make a day-trip to view the glow worms at Natural Bridge. Those on holiday usually travel to see glow worms and return to their original base. The most popular (91%) form of transport was by either a car or a van. A small number (3%) travelled by motor cycle and a few (2%) living close by walked to Natural Bridge. The average party size was 4.4 persons, including children.

Most of the survey respondents were female (54%) and the number of male respondents was 45%. Approximately 1% did not indicate their gender. Interestingly, the majority (30%) of the survey respondents belonged to the 20-30 age group followed by the 30s and 40s age groups. The visitor numbers begin to diminish quite steeply for the 50s group and the

number of 60s and those above is small (3%). From Table 5, it is clear that it is largely those under 50 who are most likely to visit. The viewing of glow worms at Natural Bridge may be less attractive to older visitors than younger persons because it is a night time activity and involves a walk along an unlit pathway with steps in places. A torch is needed for this walk. However, this does not mean that glow worms are less attractive to older visitors. It is necessary to study other sites that offer day time glow worm viewing to examine these aspects.

Table 5
Distribution of age of respondents

	Frequency	% Total
School going	2	1.1
<20 left school	6	3.4
20-30	53	29.9
31-40	40	22.6
41-50	41	23.2
51-60	28	15.8
61+	6	3.4
No Response	1	0.6
Total	177	100

Note: QPWS rangers at Natural Bridge are of the opinion that independent visitors belong to a much wider age group

As observed in other surveys involving ecotourists (Tisdell and Wilson, 2003, Tisdell and Wilson, 2002), the level of education of the responding visitors is high. The majority (37%) had a degree followed by those who had completed year 12 (16%), diplomas (15%), trade certificate (11%), postgraduate qualifications (9%), grade 10 (8%) and secondary education (3%). Close to 2% of the respondents did not answer this question.

Although the largest group (30%) of the responding visitors had a family income of more than AUS\$60,000, most of the respondents had a family income between AUS\$30,001-\$40,000 (17%) and AUS\$40,001-\$50,000 (14%). A small group of visitors (8.5%) had a family income of between AUS\$50,001-\$60,000 while the rest had an income below AUS\$30,000. The annual family income of visitors is shown in Table 6.

Table 6
Distribution of income of surveyed visitors coming
to Natural Bridge to view glow worms

Income Range	Frequency	% Total
Below \$20,000	19	10.7
\$20,001-\$30,000	20	11.3
\$30,001-\$40,000	30	16.9
\$40,001-\$50,000	25	14.1
\$50,001-\$60,000	15	8.5
\$60,001 and above	53	29.9
No Response	15	8.5
Total	177	100

A breakdown of family incomes between Australian's and foreigners show that foreigners (37%) had family incomes higher than AUS\$60,000 compared to 32% Australians. Higher family incomes among foreigners can be partly explained by the presence of Europeans and North Americans in the sample. There were also more foreigners with family incomes less than AUS\$20,000 and incomes between AUS\$40,000–\$50,000. The low-income levels among foreigners may be because of the presence of backpackers. However, for rest of the income groups, there were more Australians than foreigners.

5. Importance of Glow Worms as a Tourist Attraction

For the vast majority (84%) of the respondents their visit to Natural Bridge was the main purpose of their excursion. Most of the visitors were either day trippers (those travelling from home) and those on holiday who also decided to make it a diversionary day trip. In order to visit Natural Bridge visitors had travelled a minimum of about 1 km to a maximum of 900 km. The average distance travelled was 114 km per person or party. Despite the distance travelled, a large percentage of the visitors (96%) said that it was worthwhile travelling this distance to see the glow worms at Natural Bridge.

We asked the respondents what was the main reason for visiting to see glow worms. The main reasons cited by the visitors are listed in Table 7.

Table 7
**Frequency of responses to the question ‘What was the main purpose of
your visit to see the glow worms?’ (Semi structured question)**

	Frequency	% Total
Entertain visitors	63	25.5
Curiosity	62	25.1
Attracted by star like event	55	22.3
Amazed insects produce light	28	11.3
Other	18	7.3
Fill in spare evening	17	6.9
No Response	4	1.6
Total	247⁺	100

Note: Respondents could indicate more than one reason.

As Table 7 shows for the largest percentage of the responding visitors, the main purpose of the visit was to entertain visitors. The importance of this factor has been observed in other surveys as well (Tisdell and Wilson, 2003). This also partly explains some repeat visits to sites such as Natural Bridge. Curiosity was ranked second as the main reason for the visit followed by the star-like features of the glow worm display. Furthermore, watching glow worms to some (6.9%) was also considered to be a good way to spend the evening. The vast majority (98%) of respondents were satisfied by their visit, and said that they would recommend Natural Bridge to a friend. Only 2% said that they would not.

Despite the satisfaction derived by the visitors and the distance travelled by some visitors, the money spent by the visitors which was associated with the travel to Natural Bridge was small. It was estimated that the average expenditure per person was Aus \$7 per trip with a maximum of Aus \$ 75.¹ A few visitors said that they did not incur any costs in travelling to Natural Bridge to watch glow worms although they had travelled a considerable distance to reach Natural Bridge. No reasons were cited, but it is likely that when some parties travelled together no costs were incurred to one party. Only a few visitors travelled from the neighbourhood (within a kilometre) where the costs incurred would have been minimal.

Most of the respondents (95%) stated that their visit to see glow worms at Natural Bridge was worth their cost and effort. Only around 2% said that the cost was not worth the visit and 3% did not answer this question. Perhaps one of the reasons for many of the visitors saying that

the visit was worth the cost and effort may be because of the negligible expenditures incurred by the average visitor. Time costs were not estimated.

Of those who said that they felt that the visit to see glow worms at Natural Bridge was worth the effort and cost, 73% said that their experience was worth more than the cost and only 29% said that the experience was not worth more than the cost. Approximately 3% of the respondents did not answer this question. The high satisfaction experienced by the visitors shows the existence of a consumer surplus or an economic surplus. In order to capture this we asked the respondents:

If yes, how much more would you personally have been prepared to pay for this experience?

The average additional amount a respondent was personally prepared to pay for this experience was Aus \$19.90.² As mentioned above the average expenditure per person in travelling to Natural Bridge was Aus \$7. Since there is no entry fee at present for 'independent' visitors who come to view glow worms at Natural Bridge the average extra amount (Aus \$19.90) that the respondents were prepared to pay for the glow worm experience can be considered as the consumer surplus for the average visitor. The consumer surplus is high and it indicates that in principle scope exists to charge an entry fee to independent visitors intending to view glow worms at Natural Bridge.

The survey results indicate that there is very little local economic impact from glow worm viewing at this site in the village nearby or within 25km of it. Of the surveyed visitors, only 18.6% spent money in the local village or nearby. The majority (79.9%) did not and another 1.7% did not answer this question.³ Of the 18.6% who spent money in the village or within 25 kilometres of the site, the maximum amount spent per person was Aus \$40 and the minimum amount was Aus \$ 1.70. The average amount was Aus \$12.20.⁴ The low level spending within a 25 kilometres radius of the site could be attributed to several factors for example: (a) many tourists do not spend the night in the nearby vicinity and (b) there are no other nearby major tourist attractions/facilities in the area where tourists can spend their money. This is especially so in the evenings. For the majority of the visitors (56%) it was their first visit to watch glow worms while for 43% it was not. Only 1% did not answer this question. Of those who had visited Natural Bridge before to see glow worms, many of them had come only once or twice previously. However, there were some visitors who had come more than thrice and less than ten times. There were a few visitors who had visited Natural

Bridge more than 10 times. Most respondents learnt about the glow worms as an attraction by word of mouth either from friends or family. Independent visitors did not learn about the site very much from travel books or agents. However, Natural Bridge, like most other glow worm sites is given publicity on the internet.

Of those who were on holiday, 50% said that they knew of the existence of glow worms at Natural Bridge before they left home while 47% said they learnt about the glow worms while they were on holiday. The majority (85%) of the visitors thought that they would visit Natural Bridge again to watch glow worms while only 12% said that they would not. Approximately 3% did not answer this question. The large number of visitors saying that they were willing to return further demonstrates the overall satisfaction of visitors to Natural Bridge with their experience. This also confirms the large number of repeat visitors to Natural Bridge. In addition to visitors watching glow worms, a large number of visitors (72%) had also visited the National Park (Natural Bridge section) during the day while 28% did not. An average visitor had visited Natural Bridge National Park during the daytime around 4.6 times with some visiting as many as 20 times. These are mostly visitors who live close to the National Park. Of those who said 'no', more than half (55%) said they plan to visit it by day and 24% said 'no', while the rest did not answer this question.

6. Visitors' Knowledge of Glow Worms and Willingness to Pay to View Glow Worms

A section of the survey was designed to determine the visitors' knowledge of glow worms since it has many policy implications.

A significant number of visitors (67%) said that they obtained knowledge about the biology and ecology of glow worms during their visit to Natural Bridge. However, 32% said 'no' and 1% did not answer this question. Of those who said 'yes' (#119), 52% were 'first time' visitors and the rest were 'repeat' visitors. Of those who said 'no' (# 55), 64% were 'first time' visitors and the rest were 'repeat' visitors. The information was mainly obtained from notice boards, rangers and leaflets. In addition to asking whether they had obtained information about glow worms, the survey asked several specific questions to determine the extent of their knowledge. First, the survey asked the visitors whether they knew what glow worms were? The majority (79%) of the visitors said 'yes', while 16% said 'no' and 5% did not answer this question. Of those who said 'yes', (#139), 54% were 'first time' visitors and

the rest were ‘repeat’ visitors. Of those who said ‘no’, (#28), 64% were ‘first time’ visitors and the rest were ‘repeat’ visitors. In order to determine how much the visitors knew about glow worms, we asked the following question:

‘What is the reason for glow worms lighting up?’ The answers to this question are shown in Table 8.

Table 8
Distribution of responses to the structured question:

‘What is the reason for glow worms lighting up?’

	Frequency	% Total
To attract insects only	114	64.4
To attract mates	22	12.5
Don’t know	23	13
To attract mates and to attract insects	08	4.5
No Response	6	3.2
Other	3	1.6
To enable them to see	01	0.6
Total	177	100

Table 8 indicates that the majority of the respondents (64.4%) knew that the reason for glow worm lighting is to attract insects for food. However, the rest did not know the reason for their lighting up, and they included repeat visitors. Of those who knew the answer to this question, 53% were ‘first time’ visitors and the rest were ‘repeat’ visitors. Of those who did not know the reason for glow worms lighting up, 62.5% were ‘first time’ visitors and the rest were ‘repeat’ visitors. Furthermore, we asked the visitors what spiders and glow worms have in common? The responses are shown in Table 9.

Table 9:
Distribution of responses to the structured question:

‘What do spiders and glow worms have in common?’

	Frequency	% Total
Both have sticky threads	123	69.5
Don’t know	34	19.2
Both insects	13	7.3
No Response	6	3.4
Both Poisonous	1	0.6
Total	177	100

Close to 70% of the visitors knew that both species have sticky threads. Approximately 7% of the visitors also said that both spiders and glow worms were insects which is technically incorrect because spiders belong to the Class Arachnida, not the Class Insecta. However, it demonstrates that the respondents had some idea of the relatedness of spiders and insects. The rest did know the answer to this question. Of those who knew these facts 54% were ‘first time’ visitors and the rest (46%) were ‘repeat’ visitors.

Of those who did not know what spiders and glow worms have in common, 62.5% were ‘first time’ visitors and the rest were ‘repeat’ visitors. With regard to the question ‘Is the glow worm only one stage of the life of an insect?’ 59% said ‘yes’ and 11% said ‘no’. However, 26% said they ‘don’t know’ and 3% did not answer this question. Of those who said ‘yes’ many mentioned the names of insects and 17% said ‘don’t know’. Of those who knew that the glow worm was only one stage of the life of an insect, 54% of them were ‘first time’ visitors and 46% were ‘repeat visitors. Of those who did not know this fact, 58% were ‘first time’ visitors and 42% were repeat visitors. The replies of those saying ‘yes’ are showing in Table 10.

Table 10
Distribution of responses to the structured question:
‘what do the adults look like’

	Frequency	% Total
Moth	23	21.9
Fruit flies	29	27.6
Other	23	21.9
Don’t Know	18	17.1
Beetles	7	6.7
Blowflies	5	4.8
Total	105	100

Table 10 shows that despite 59% of the visitors saying that the glow worm is only one part of the life of an insect, many were unsure what the adult looked liked. Only 13.3% of the visitors (from the ‘other’ category) knew that the adults resembled a mosquito-like fly. However, 27.6% were of the view that the adult glow worm looked like fruit flies which is the next nearest correct answer. Interestingly, 21.9 of the respondents said that the adults looked like moths and 6.7% said they looked like beetles.

Furthermore, with a view to increasing the knowledge of visitors of glow worms and increasing the educational component of the experience at Natural Bridge the survey asked visitors the following question:

Do you think that it would be useful to be able to purchase a small booklet at Natural Bridge explaining the biology/ecology of glow worms?

The majority of visitors (81%) answered 'yes' to this question while only 18% did not like the idea. Another 1% did not answer this question. However, only 68.4% of the visitors said that they would have been inclined to purchase such a book during the visit, while 29.4% answered 'no' and there was no response from 2.2% of the participants. Of those who said 'yes', the average amount the respondents were prepared to spend for an information booklet of around 12 pages was Aus \$3.80. The maximum amount stated was Aus \$10.

In addition we also asked visitors whether walk-in visitors should pay an entrance fee to see the glow worms. The question was framed as follows:

Do you believe that walk-in visitors (those not on group visits organized by bus companies) should pay an entrance fee to see the glow worms at Natural Bridge?

The responses show that the majority of the respondents (73%) said 'no' and only 24% thought that they should pay an entrance fee. Close to 3% did not answer this question. Previous studies, such as the Lamington National Park case study reported earlier indicate that most Australians oppose fees for entry to national parks. This aspect, however, needs further investigation because strategic bias may be present. See, for example, Wilson and Tisdell (2003).

The study also enquired about congestion experienced by visitors while viewing glow worms. For this purpose the following question was asked:

Did you feel inconvenienced by other visitors while viewing glow worms?

Close to 60% of the visitors said that they did not experience any such inconvenience when viewing glow worms, but 40% said they did. Furthermore, we asked the responding visitors whether they 'would like a close up view of glow worms even if they were in an artificial environment'. Interestingly, 58% said that they would like such a close up view. However, 40% said 'no' to such an idea. Approximately 2% did not answer this question. The majority

(88%) of the visitors said they would like to see a display centre at Natural Bridge containing exhibits that fully explained the life history of glow worms and the reasons for their presence at Natural Bridge. Only 11% did not like the idea and around 1% did not answer this question. Of those who said 'yes', 98% said that assuming that the exhibit was of good quality, that they would have made use of it. None of the respondents said 'no' and around 2% did not answer this question. The survey results show that a display centre would be used by most visitors. Such a centre has the potential to enhance the visitors' learning experience and increase the appreciation of glow worm viewing.

The study also asked the visitors what entry fee would be reasonable to charge to cover the cost of providing an interpretive centre. According to the responses the respondents were of the view that it was reasonable to charge an entry fee of Aus \$3.70 for an adult on average for such a service with a maximum of Aus \$15. However, approximately 9% of those who answered this question said that visitors should not pay an entrance fee to cover the cost of an interpretive centre. For children the average rate was Aus \$1.60 with a maximum of Aus \$10 and 23% said children should not pay. The average amount suggested for pensioners was slightly higher (Aus \$1.90) and the maximum amount was Aus \$10 with 18% of respondents saying that pensioners should not pay an entrance fee.

7. Knowledge About the Existence of Other Glow Worm Viewing Sites in the Region

In the survey, we wanted to determine whether or not the visitors were aware of the existence of other glow worm sites in the area, including the 'Forest of Dreams' at Springbrook. Only a small percentage of visitors knew about their existence. For instance, only about 10% of the respondents to Natural Bridge knew about the existence of the 'Forest of Dreams' and only two had actually visited the place. Most of the visitors who knew about the existence of the 'Forest of Dreams' were repeat visitors and were Australians. Of those who said 'no' (82%), more than half (53%) said that they would have liked a chance to visit the 'Forest of Dreams'. Around 40% said 'no' and 6% did not answer this question. In addition to the questions relating to the 'Forest of Dreams', we asked the visitors whether they knew 'that glow worms also occur naturally at Mount Tamborine National Park in the hinterland of the Gold Coast' north of Natural Bridge. Only 23% knew about the presence of glow worms occurring at Mount Tamborine National Park. The majority of the visitors (75%) did not know of the existence of glow worms there and 2% did not answer this question.

8. Conclusions

The glow worm colony in Springbrook National Park (Natural Bridge section) is one of the largest in Australia and attracts close to 60,000 visitors a year, both independent visitors and those brought in by commercial tour operators. However, as shown in Table 23 the majority of tourists (mainly Asian) are brought by commercial operators as part of a pre-paid Australian tour although commercial tour operators cater for several other groups as well. Although this form of tourism has remained largely understudied and its contribution to tourism unnoticed, glow worms at Springbrook National Park attract more visitors annually than turtle viewing at Mon Repos and a few thousand less than whale-watching at Hervey Bay (Wilson and Tisdell, 2003). However, the latter ecotourism activities occur only for a part of the year whereas glow worm viewing does not. While the bulk of tourists brought by commercial tour operators are Asian, the majority of the surveyed visitors (83.6%) are Australians and most of the foreigners are from the UK, US and New Zealand.

The study found that most of the independent visitors are day-trippers including those on holidays. The number of visitors who stayed in Springbrook because of the presence of glow worms was negligible and no extra days were spent in the area because of the presence of glow worms. Furthermore, the amount of money spent by the tourists in the area (within a 25 km radius) is also small and hence the economic impacts from this form of tourism is not significant to the immediate local economy. However, this does not mean that free glow worm viewing at Springbrook National Park is not a valuable economic asset. Commercial tour operators' fees for the excursion that involves glow worm viewing are high and judging by the number of visitors (Table 23) the revenue generated by this activity in the Gold Coast region/southeast Queensland region must be considerable. Furthermore, there are two private properties in Springbrook that offer glow worm viewing facilities during the day and at night they charge a fee and maintain a restaurant and conduct other activities (eg. pottery displays, etc) to 'add value' to their business operations. Although annual visitation figures are not available, these sites are popular among tourists.

The knowledge of glow worms of the majority of visitors was high (although there was uncertainty regarding more specific questions such as 'what do the adult glow worms look like') indicating that they had read about glow worms before their visit. Furthermore the majority of the visitors were willing to purchase a booklet that explained the biology and ecology of glow worms. The majority of the visitors indicated that most visitors were

satisfied with their glow worm experience and were of the view that the visit was worth the cost and effort. The average cost per visitor of travelling to Natural Bridge was Aus \$7 and the average respondent was prepared to personally pay Aus \$ 19.90 more for the experience. However, the majority (73%) of the visitors believed that walk-in visitors should not pay an entrance fee to see the glow worms at Natural Bridge.

Overall, glow worm viewing remains a popular tourist activity and the majority of the visitors have high satisfaction rates visiting the colony of glow worms at Springbrook National Park (Natural Bridge section). There is also a large number of repeat visitors travelling on their own or accompanying others and stating that they would talk to friends and relatives about their experience at this site. The popularity of glow worms is also confirmed by the existence of two privately run commercial glow worm sites in the Springbrook area.

The study has examined some aspects of an insect-based tourism activity that has remained largely understudied and under-estimated in its potential to generate economic and social benefits. The results of the study are useful to further improve facilities such as interpretation services and to help enhance the glow worm viewing experience.

9. Acknowledgements

We wish to thank the Sustainable Tourism Co-operative Research Centre (STCRC) for some financial support for this study and Joel Ickiewicz and Alex Park for their research assistance. We also thank Rachael Niotakis, Tanya Sweeney and other QPWS staff for organizing and distributing survey forms among the independent visitors to Natural Bridge to view glow worms. Special thanks to Tanya Sweeney for providing Natural Bridge glow worm 'visitor data' and other information. We also thank QPWS for giving us permission to conduct this survey at Natural Bridge. We greatly appreciate the support given by QPWS. Without this support the survey would not have been possible. Special thanks to Craig Mosely for the excellent job he did in preparing the maps. The usual caveat applies.

NOTES:

- 1 For the calculation seven large groups (some groups had more than 50 adults) were removed and some of them are possibly school groups.
- 2 The figure was estimated by taking into account only those who said that their glow-worm experience was worth more than the cost. There were 123 respondents who

said yes out of which 41 did not say how much more they would personally have been prepared to pay for this experience. Furthermore an outlier of \$550 was removed together with seven respondents who said they were willing to pay 'nothing'.

- 3 Only the responses of 170 visitors were taken into account. Seven 'large parties', eg. school parties, were removed for this analysis.
- 4 One outlier was removed to estimate how much money was spent in the local area.

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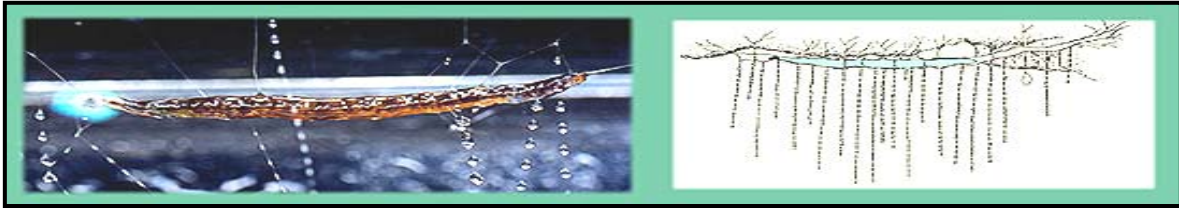
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Appendix:

Glow worm survey questionnaires distributed among independent visitors to Springbrook National Park (Natural Bridge section) to view glow worms.

GLOW WORMS



TOURISM SURVEY OF 'WALK-IN' VISITORS* TO SEE GLOW WORMS AT NATURAL BRIDGE NATIONAL PARK

This research study is being conducted by Clem Tisdell and Clevo Wilson, researchers from The University of Queensland. It is supported by the Australian Cooperative Research Centre for Sustainable Tourism. We would like your help. We need information about your visit to this site. Could you spare a little while to answer some of our questions? Your answers will be confidential and used only for scientific purposes. **Please post the completed survey forms without delay in the self addressed envelope (postage prepaid).** Thank you for your anticipated help.

-
1. Date and time of commencing visit at Natural Bridge to see glow worms.
Day of week Approx time Date (d/m/y)
 2. In what **country** do you permanently reside?
 3. If Australian, in what **State** do you permanently reside?
 4. Please give your postcode in Australia
 5. Did you visit Natural Bridge
☐ while on holiday, that is, a trip involving a stay of at least **one night** away from home.
☐ as a day excursion, that is as part of a journey **not** involving an overnight stay away from home
 6. On the day of your travel to Natural Bridge to see glow worms, in what place, town or city did you start your journey?

* This survey is intended for visitors who are not part of a commercially arranged tour group arriving by bus to see the glow worms at Natural Bridge National Park.

7. After you went to Natural Bridge to see glow worms, did you spend the night at the place where you started your trip? ☐ Yes ☐ No

If **No**, in what town or locality did you stay that night?

8. By what form of transport did you travel to Natural Bridge?

☐ Car/van ☐ Motor bike ☐ Other (please specify)

9. How many were in your party (**eg. an individual, couple or family**) including yourself?

Number of adults Number of children

10. Did you stop at any other attractions on your way to Natural Bridge? ☐ Yes ☐ No

If **Yes**, please list these.

(a) (b)

11. Do you consider that your visit to Natural Bridge was the **main** purpose for the excursion that included it? ☐ Yes ☐ No

12. Approximately how many kilometres **in total** did you travel by road to include Natural Bridge glow worms specifically in your travel itinerary?

km (approximately)

13. Did you feel that it was worthwhile travelling this **distance** to see the glow worms at Natural Bridge? ☐ Yes ☐ No

14. How much do you estimate that you (or, if accompanied, your whole party) spent specifically for the purpose of visiting Natural Bridge to see glow worms?

Total AUS\$ (approx) for **person(s)**

15. Do you feel that your visit to see glow worms at Natural Bridge was worth the cost and effort? ☐ Yes ☐ No

If **Yes**, do you feel this experience was worth more than the cost? ☐ Yes ☐ No

If **Yes**, how much **more** would you **personally** have been prepared to pay for this experience? AUS\$.....

16. On the day of your visit to Natural Bridge National Park to see glow worms, did you or your travel party spend any money at the village nearby or within 25 km (approx) of it?

☐ Yes ☐ No

If **Yes**, how much did you (or, if accompanied, your party) spend?

Total AUS\$ (approx) for **person(s)**

17. Was this your first visit to Natural Bridge to see glow worms? ☐ Yes ☐ No

If **No**, how many times have you visited before to see glow worms?

18. Have you seen glow worms before? ☐ Yes ☐ No

If **Yes**, where did you see them previously?

19. How did you learn about the glow worms as an attraction at Natural Bridge? Please state source or sources of information.

☐ Friend ☐ Travel agent ☐ Travel book ☐ Other (please specify)

20. If you are on **holiday** (not a day tripper), did you know of the glow worms at Natural Bridge before you left home? ☐ Yes ☐ No

21. What was the main purpose(s) of your visit to see the glow worms?

☐ Entertain visitors ☐ Fill in spare evening while holidaying ☐ Curiosity

☐ Attracted by this spectacular star-like event ☐ Amazed that insects can produce light

☐ Other (please specify)

22. Would you recommend a visit to friends? ☐ Yes ☐ No

23. Do you expect to visit Natural Bridge National Park again, at a future time, to look at the glow worms again? ☐ Yes ☐ No

24. Have you visited Natural Bridge National Park during the daytime? ☐ Yes ☐ No

25. If **Yes** to 24, how many times have you visited it by day?

If **No** to 24, do you plan to visit it by day? ☐ Yes ☐ No

Knowledge of Glow Worms

26. Did you obtain any knowledge about the biology and ecology of glow worms during your visit? ☐ Yes ☐ No

If **Yes**, what was the source of that knowledge?

27. Do you know what glow worms are? ☐ Yes ☐ No

28. What is the reason for glow worms lighting up?

☐ To attract mates ☐ To attract flying insects ☐ To enable them to see at night
☐ Other (please specify) ☐ Don't know

29. What do many spiders and glow worms have in common?

☐ Both are poisonous ☐ Both are insects
☐ Both have sticky threads to catch insects which they eat ☐ Don't know

30. Is the glow worm only one stage in the life of an insect? ☐ Yes ☐ No ☐ Don't know

31. If **Yes**, what do the adults look like?

☐ Moths ☐ Fruit flies ☐ Beetles ☐ Blowflies
☐ Other (please specify) ☐ Don't know

Other Questions

32. Do you think that it would be useful to be able to purchase a small booklet at Natural Bridge explaining the biology/ecology of glow worms? ☐ Yes ☐ No

33. Would you have been inclined or bothered to purchase such a booklet on your visit?

☐ Yes ☐ No

If **Yes**, How much would you be prepared to spend, say for an informative booklet of around 12 pages?

AUS\$.....

34. Do you believe that walk-in visitors (those not on group visits organized by bus companies) should pay an entrance fee to see the glow worms at Natural Bridge?

☐ Yes ☐ No

Why?

35. Did you feel inconvenienced by other visitors while viewing glow worms?

☐ Yes ☐ No

If **Yes**, please explain.....

36. Would you like a close-up view of living glow worms even if they were in an artificial habitat? ☐ Yes ☐ No

37. Would you like to see a display centre at Natural Bridge containing exhibits that fully explain the life history of glow worms and the reason for their presence at Natural Bridge?
☐ Yes ☐ No

38. If **Yes** to 37, assuming that the exhibit was of a good standard, would you have made use of it on your visit? ☐ Yes ☐ No

39. If an entry fee had to be charged to cover the cost of the type of interpretative centre mentioned in 37, what entry charges to this facility would be reasonable in your view?

Adults \$..... Children \$..... Pensioners \$.....

40. Do you have any suggestions for improving the facilities at the Natural Bridge site?

.....

41. Do you know of the 'Forest of Dreams' at Springbrook? ☐ Yes ☐ No

42. If **Yes** to 41, have you visited it? ☐ Yes ☐ No

43. If **Yes** to 42, when did you visit it?

If **No** to 42, why have you not visited it?

44. If **No** to 41, the 'Forest of Dreams' is a privately owned tourist attraction that has established an 'artificial' colony of glow worms, and is unique in this regard. The glow worms can be seen during the day at the 'Forest of Dreams' and the site is not too distant from Natural Bridge. Would you like to have had a chance to visit the 'Forest of Dreams'?

☐ Yes ☐ No

45. Do you know that glow worms also occur naturally at the Mount Tamborine National Park in the hinterland of the Gold Coast? ☐ Yes ☐ No

If **Yes**, and you have visited this Park to see glow worms, how does the display at Natural Bridge compare with that at Mount Tamborine?

☐ Much more spectacular ☐ Much the same ☐ Not as spectacular

Background Attributes

46. Gender of person filling out the form? Male ☐ Female ☐

47. To what age group do you belong?

School going ☐ <20 left school ☐ 20 – 30 ☐
31 – 40 ☐ 41 – 50 ☐ 51 – 60 ☐
61 + ☐

48. Indicate your highest educational qualification

Primary only ☐ Some secondary schooling ☐ Completed year 10 secondary ☐
Completed year 12 ☐ Trade certificate ☐ Diploma ☐
Degree ☐ Post-graduate degree ☐ Any other

49. Your family income level per annum in Australian dollars?

Note: This is **confidential** and for **scientific research only**

Below AUS\$20,000 ☐ AUS\$20,001 - 30,000 ☐ AUS\$30,001 - 40,000 ☐
AUS\$40,001 - 50,000 ☐ AUS\$50,001 - 60,000 ☐ AUS\$60,001 and above ☐

50. In what country were you born?

51. If born outside Australia, and live in Australia, how many years have you lived here?

..... years

52. Would you describe yourself as

☐ a strong advocate of nature conservation
☐ a moderate advocate of nature conservation
☐ and advocate of the view that nature conservation should not be allowed to stand in the way of economic growth

THANK YOU FOR YOUR COOPERATION

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